Pol. J. Food Nutr. Sci., 2012, Vol. 62, No. 1, pp. 57-60
DOI: 10.2478/v10222-011-0040-6
http://journal.pan.olsztyn.pl

Original Paper
Section: Nutritional Research

Effect of Olive Oil with Low Calorie Diet on Blood Lipids in Hyperlipidemic Patients

Mostafa Noroozi[1], Roza Zavoshy[1], Hassan Jahanihashemi[2]*

[1]Department and Laboratory of Human Nutrition, Qazvin University of Medical Sciences, 34197–59811 Qazvin, Iran
[2]Department of Biostatistics, Qazvin University of Medical Sciences, 34197–59811 Qazvin, Iran

Key words: olive oil, low calorie diet, hyperlipidemia, serum lipids

Serum lipid abnormality is a risk factor for cardiovascular disease. The aim of this research was to study the effect of olive oil with low-calorie diet on blood lipids in hyperlipidemic patients. The study was done on fifty eight hyperlipidemic patients of both sexes and age range of 25–65 years. The patients received low-calorie diet based on 1400 kcal energy per day for 4 weeks, containing 32% fat, 18% protein and 50% carbohydrate. The intervention group received low-calorie diet including 30 g/d olive oil. Weight, body mass index, waist and hip circumferences were significantly reduced ($p<0.05$) after 4 weeks in both groups. Treatment with olive oil was associated with a significant reduction ($p<0.05$) in low density lipoprotein.

INTRODUCTION

Cardiovascular disease affects the heart and blood vessels. It is the leading cause of death and permanent disability [Olufadi & Byrne, 2006]. Serum lipid abnormalities are major risk factors for noncomunicable disease [Naghavi *et al.,* 2007]. Olive oil is the main source of fat in the Mediterranean diet [Psaltopoulou *et al.,* 2004], may have health benefits, including the reduction of coronary heart disease risk [Trichopoulos *et al.,* 2004; Martinez-Gonzalez & Sanchez-Villegas, 2004]. Olive oil is known for its high levels of monounsaturated fatty acids (MUFA) and it is a good source of phytochemicals, such as polyphenolic compounds, squalene and α-tocopherol [Stark & Madar 2002; Fito *et al.,* 2007; Cicerale *et al.,* 2009].

Jespersen *et al.* [2001] reviewed fifteen studies on dietary olive oil. He observed the consumption of olive oil was associated with significantly raised plasma concentration of low-density lipoprotein cholesterol (LDL), high-density lipoprotein cholesterol (HDL). Rueda-Clausen *et al.* [2007] reported that dietary intervention with olive oil in comparison with alternative vegetable oils increased triacylglycerols (TAG). Although, in a recent study in obese subjects, a dietary treatment with olive oil indicated that LDL cholesterol and TAG were reduced [Perez-Guisado *et al.*. 2008] and in elderly subjects, olive oil consumption showed a reduction in serum total and LDL cholesterol [Haban *et al.,* 2004; Salas Salvado *et al.,* 2008]. Binkoski *et al.* [2005] reported that olive oil dietary intervention compared with sunflower oil was associated with no effect on total and LDL cholesterol and TAG. Results from different studies on the effect of olive oil consumption on lipid profile are inconsistent and there are few data focusing on the effect of olive oil with a low-calorie diet on blood lipids in hyperlipidemic patients. Hence, the objective of this study was to investigate the effect of olive oil with low-calorie diet on blood lipids, TAG, TC (total cholesterol), LDL and HDL in hyperlipidemic patients. Healthy diet can be used instead of long-term medications with several side effects in hyperlipidemic patients.

MATERIAL AND METHODS

Subjects

This randomised clinical trial was conducted on hyperlipidemic patients. Fifty eight subjects (51 females and 7 males) participated in this study. They were randomly divided into treatment (n=29, 24 females and 5 males) and control (n=29, 27 females and 2 males) groups. The patients who were healthy in other respects were recruited from nutrition and diet therapy clinic in Qazvin. For the personal reasons, two subjects of the control group dropped out before the end of the study. The inclusion criteria required the age of 25–65 years. They had at least one of blood lipid indices including TC ≥200, HDL ≤40, LDL ≥130 and TAG ≥150 mg/dL. Exclusion criteria included pregnancy and lactation, smoking, steroid therapy, taking lipid-lowering drugs, hormones and a personal history of nephropathy, cardiovascular disease, diabetes or other chronic disease.

Protocol

All subjects received advice from a registered dietetian to follow a low-calorie diet (32% fat, 18% protein and 50% car-

* Corresponding author: Tel: +98281 3674477; Fax: +98281 3673229
E-mail: rzavoshy@yahoo.com, rzavoshy@qums.ac.ir (Roza Zavoshy, PhD)

bohydrate) based on 1400 Kcal energy per day for 4 weeks. The olive oil was produced by Kokab (Olive Oil Company, Qazvin, Iran) and had a national quality control certificate number 1446 and contained: 69.1% MUFA, C18:1, 12.5% PUFA, C18: 2 & 3 and 18.4% saturated fatty acids (SFA, C14–C22). The low-calorie diet including olive oil was well tolerated and accepted. Oral and written instructions for recording foods were given to all subjects by the clinical nutritionist. Seven-day food records were completed by subjects during the last week of the study. These records were reviewed by the clinical nutritionist for checking the diet compliance. Subjects' compliance was assessed by analysing the records using a computerised nutrient database (Dorosty Food Processor, version 2003, Shahid Beheshti University, Tehran, Iran), which is mainly based on the national food composition data. Blood samples were obtained after an overnight (12 hours) fasting period before the study and in the last day of the intervention period. Anthropometric indices and levels of serum TAG, TC, LDL and HDL were measured before and after the intervention. Serum total cholesterol and triacylglycerol concentrations were measured by commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran) adapted to Selectra autoanalyser (Vital Scientific, Spankeren, Netherlands). HDL-cholesterol was measured after precipitation of the apolipoprotein B containing lipoproteins with phosphotungstic acid [Burstein *et al.,* 1970]. Inter-and intra-assay coefficients of variation were both less than 5% for all these measurements. All participants provided informed written consent. The protocol was approved by the Research Council and Ethical Committee of Qazvin University of Medical Sciences.

Measurements

Body weight was measured while the subjects were minimally clothed, without shoes. Digital scales were used and recorded to the nearest 0.1 kg. Height was measured in a standing position, without shoes, using a tape meter while the shoulders were in a normal state. Waist circumference was measured to the nearest 0.1 cm at the narrowest level over light clothing, using an unscratched tape measure, without any pressure to body surface. During the study, participants were asked not to change their habitual physical activity levels.

Statistical analysis

Results are presented as mean±standard deviation. Statistical analysis was performed by descriptive statistics and using paired t-test, for change in each group, independent t-test for baseline and after intervention comparison in two groups, one sample t-test for decreasing of blood lipids ($\alpha=0.05$).

RESULTS AND DISCUSSION

The mean age of subjects was 40.5±11.0 years and the average of body mass index (BMI) and waist-to-hip ratio (WHR) were 33.8±5.8 kg/m^2 and 0.96±0.07, respectively. There were no significant differences in age, weight, height, waist, hip, BMI, WHR, TC, TAG, LDL, HDL, LDL/HDL and Chol/HDL between the two groups (treatment and control) at the baseline (Table 1). Weight, BMI, waist and hip circumferences were significantly reduced ($p<0.05$) after 4 weeks in both groups (Table 2).

TABLE 1. Characteristics of hyperlipidemic patients at baseline.

Characteristics	Treatment group (mean±SD)	Control group (mean±SD)	p value
Age (yrs)	41.3±11.2	39.7±10.9	0.57
Weight (kg)	89.2±16.1	83.1±17.5	0.67
Height (cm)	160.1±7.9	158.8±7.3	0.52
Waist (cm)	113.0±16.2	108.4±14.4	0.47
Hip (cm)	117.0±14.4	112.3±11.3	0.18
BMI (kg/m^2)	34.8±6.1	32.7±5.4	0.47
WHR (ratio)	0.97±0.07	0.96±0.07	0.93
TC (mg/dL)	229.7±42.5	216.7±19.6	0.19
TAG (mg/dL)	223.3±81.4	177.8±87.1	0.07
LDL (mg/dL)	138.0±40.2	128.7±25.1	0.48
HDL (mg/dL)	45.1±12.6	46.5±10.4	0.66
LDL/HDL	3.2±1.1	3.0±0.94	0.39
Chol/HDL	5.4±1.5	5.0±1.5	0.26

BMI – body mass index; WHR – waist to hip ratio; TC – total cholesterol; TAG – triacylglycerides; LDL – low-density lipoprotein; HDL – high-density lipoprotein; SD – standard deviation.

There were no significant differences at the beginning of dietary intervention (baseline) between plasma lipid concentrations. Olive oil with low-calorie diet intervention was associated with a significant reduction in serum LDL (138.0±40.2 mg/dL *versus* 118.7±37.8 mg/dL, $p<0.05$). Intervention diet significantly decreased TC and TAG compared with the baseline (229.7±42.5 mg/dL *versus* 197.4±40.4 mg/dL and 223.3±81.4 mg/dL *versus* 177.2±75.5, respectively, $p<0.05$) but compared with the control group, these changes were insignificant. No significant change occurred in HDL, LDL/HDL and Chol/HDL. Lipid profiles before and after intervention, in both groups, are summarised in Table 2.

In our previous studies, low calorie diet with soy protein intervention in hyperlipidemic type 2 diabetic patients [Noroozi *et al*., 2008] and in hyperlipidemic patients [Noroozi *et al*., 2011], also dietary intervention with canola oil [Noroozi *et al*., 2009] as a part of healthy diet improved the lipid profile. Moreover, beneficial effects of hypocaloric diet [Tapozada *et al.*, 2007] and soy protein [Ghanem, 2007] on blood lipids were reported.

In the current study the treatment with diet including olive oil for 4 weeks resulted in a significant decrease in LDL cholesterol by 12.5%. However, an insignificant change occurred in other blood lipid parameters. Salas Salvado *et al.* [2008] reported that after consumption of 1 L/week of olive oil for one year in hyperlipidemic subjects, lower incidence of elevated TAG was seen. In another study with Mediterranean diet including olive oil as the principal source of fat for 12 weeks TC and TAG levels were reduced [Perez-Guisado *et al.,* 2008]. Our results are not consistent with observations of Salas Salvado *et al.* [2008] and Perez-Guisado *et al.* [2008], which at a higher amount of olive oil and longer study period resulted in a reduction of TC and TAG.

TABLE 2. Characteristics of 58 hyperlipidemic patients before and after treatment.

Characteristics	Treatment group n=29		Control group n=29	
	Before	After	Before	After
Weight (kg)	89.2±16.1	85.1±17.5*	83.1±17.5	79.1±16.6*
Waist (cm)	113.0±16.2	108.2±15.8*	108.4±14.4	104.2±14.3*
Hip (cm)	117.0±14.4	113.3±13.6*	112.3±11.3	108.7±10.9*
BMI (kg/m^2)	34.8±6.1	33.2±5.9*	32.8±5.4	31.2±5.3*
TC (mg/dL)	229.7±42.5	197.4±40.4*	216.7±19.6	189.6±30.6*
TAG (mg/dL)	223.3±81.4	177.2±75.5*	177.8±87.1	113.7±39.2*
LDL (mg/dL)	138.0±40.2	118.7±37.8*	128.7±25.1	117.8±31.1
HDL (mg/dL)	45.1±12.6	41.1±11.3	46.5±10.4	45.6±10.2
LDL/HDL	3.2±1.1	3.1±1.4	3.0±0.94	2.7±0.8
Chol/HDL	5.4±1.5	5.1±1.7	5.0±1.5	4.4±0.9

Values are means ± standard deviation; TC – total cholesterol; TAG- triacylglycerides; LDL – low-density lipoprotein; HDL – high-density lipoprotein; BMI – body mass index WHR – waist to hip ratio; *p <0.05 (Paired *t*-test).

Consistent with our result, consumption of 40 mL/day olive oil in mildly dyslipidemic patients after seven weeks intervention showed no effect on TC and HDL cholesterol [Rudd *et al.,* 2005]. Also Binkoski *et al.* [2005] found no changes in TC after 4 weeks consumption of olive oil. HDL cholesterol remained unchanged after two weeks of dietary olive oil intake [Rueda-Clausen *et al.,* 2007]. In agreement with our results, Haban *et al.* [2004] observed that the consumption of two tablespoons of olive oil, for six weeks, significantly lowered the concentration of LDL cholesterol. In thirty one obese subjects, dietary effects of olive oil showed a significant reduction in TAG and LDL cholesterol [Perez-Guisado *et al.,* 2008]. Also, Cullinen *et al.* [2006], Waterman *et al.* [2007], and Covas [2007] observed that dietary treatment with olive oil resulted in a significant reduction in serum LDL concentration. Atherosclerosis is the most common cause of coronary heart disease (CHD). The first observable event in the process of atherosclerosis is the accumulation of plaque cholesterol from LDL in large and medium arteries [Rudd *et al.,* 2005]. The effect of LDL reduction by olive oil consumption is beneficial for CHD prevention [Covas, 2007]. A decrease of 1 mg/dL in LDL cholesterol results in about a 1% to 2% decrease in the risk factor for CHD [AHA, 2006]. Oxidized LDL appears to play an important role in atherogenesis [Lapointe *et al.,* 2006]. Olive oil is rich in MUFA and oleic acid (C18:1), generates LDL particles which appear to be more resistant to oxidation [Gimeno *et al.,* 2007]. The reduction of oxidative effect, thrombogenicity and the formation of plaque can explain the preventive effects of olive oil on atherosclerosis development [Cullinen *et al.,* 2006]. In some intervention studies, three-day food record was used [Sodergren *et al.,* 2001] to reach a more accurate estimation of energy and macronutrients intake, the subjects of this study were asked to record their foods for one week. Our study has limitations, such as the small number of participants, hyperlipidemic patients, who did not receive lipid-lowering drugs. Strengths of the study are that it reproduced real-life conditions with home-prepared foods for the diet, used supplemental foods that are commonly available and consumed by the public.

CONCLUSION

In conclusion, according to the results, we can mention that olive oil with low-calorie diet, as a part of healthy diet, lowered the LDL levels. This effect is beneficial and may reduce the cardiovascular risk factor in patients with hyperlipidemia.

ACKNOWLEDGEMENTS

The authors would like to thank the Deputy of Research, Qazvin University of Medical and Health Sciences, Qazvin, Iran, for financial support (Grant No. 28.20.52). The authors also thank Mr. Mohmmad Reza Hatefi, Chemical Engineer and manager of Kokab Olive oil Company, Qazvin, Iran for financial support and olive oil dedication. We would also like to thank Dr. Saeed Assefzadeh, Department of Social Medicine for consultation and Mrs. Mohtaram Adineh, Laboratory of Human Nutrition, Qazvin University of Medical Sciences for analysing the data on diet composition.

REFERENCES

1. AHA, American Heart Association: Healthy lifestyle diet and nutrition, from [http://www.heart.org/presenter.jhtml?identifier=1200010], accessed September 10, 2006a.
2. Binkoski A.E., Kris E., Wilson T., Mountain M.L., Nicolosi R.J., Balance of unsaturated fatty acids is important to a cholesterol-lowering diet: comparison of mid-oleic sunflower oil and olive oil on cardiovascular disease risk factors. J. Am. Diet. Assoc., 2005, 105, 1080–1086.
3. Burstein M., Scholnick H.R., Morfin R., Rapid method for the isolation of lipoproteins from human serum by precipitation with polyanions. J. Lipid Res., 1970, 11, 583–595.
4. Covas M.I., Olive oil and the cardiovascular system. Pharmacol. Res., 2007, 55, 175–186.
5. Cicerale S., Conlan X.A., Sinclair A.J., Keast R.S., Chemistry and health of olive oil phenolics. Crit. Rev. Food Sci. Nutr., 2009, 49, 218–236.
6. Cullinen K., Olive oil in the treatment of hypercholesterolemia. Med. Health R. I., 2006, 89, 113.

7. Fito M., de la Torre R., Farre-Albaladejo M., Khymenetz O., Marrugat J., Covas M.I., Bioavailability and antioxidant effects of olive oil phenolic compounds in humans: a review. Ann. Ist Super Sanita., 2007, 43, 375–381.
8. Ghanem K.Z., Beneficial effects of soybean protein and isoflavone extract supplementation on bone density and plasma lipids in females rats. Pol. J. Food Nutr. Sci. 2007, 57, 103–108.
9. Gimeno E., de la Torre-Carbot K., Lamuela-Raventós R.M., Castellote A.I., Fitó M., de la Torre R., Covas M.I., López-Sabater M.C., Changes in the phenolic content of low density lipoprotein after olive oil consumption in men. A randomized crossover controlled trial. Brit. J. Nutr., 2007, 98, 1243–1250.
10. Haban P., Klvanova J., Zidekova E., Nagyova A., Dietary supplementation with olive oil leads to improved lipoprotein spectrum and lower *n*-6 PUFAs in elderly subjects. Med. Sci. Monit., 2004, 10, 149–154.
11. Jespersen L., Jakobsen M.U., Hasseldam H., Marckmann P., The effect of dietary oils on blood lipids and the risk of ischemic heart disease with special emphasis on olive oils. Ugeskr Laeger., 2001, 163, 4736–4740.
12. Lapointe A., Couillard C., Lemieux S., Effects of dietary factors on oxidation of low-density lipoprotein particles. J. Nutr. Biochem., 2006, 17, 645–658.
13. Martinez-Gonzalez M.A., Sanchez-Villegas A., The emerging role of Mediterranean diets in cardiovascular epidemiology: monounsaturated fats, olive oil, red wine or the whole pattern? Eur. J. Epidemiol., 2004, 19, 9–13.
14. Naghavi M., Falk E., Hecht H.S., Jamieson M.J., Kaul S., Berman O., Cohn Z., Budoff M.J., Rumberger J., Naqvi T.Z., Shaw L.J., Faergeman O., Cohn J., Bahr R., Koenig W., Demirovic J., Arking D., Herrea V.L., Badimon J., Goldestin J.A., Rudy Y., Airaksinen J., Schwartz R.S., Riley W.A., Mendes R.A., Douglas P., Shah P.K., Shape Task Fore. From vulnerable plaque to vulnerable patient-Part III: Executive summary of the Screening for Heart Attack Prevention and Education (SHAPE) Task Force report. Am. J. Cardiol., 2007, 99, 1481–1482.
15. Noroozi M., Zavoshy R., Jahanihashemi H., The effects of low calorie diet with soy protein on cardiovascular risk factors in hyperlipidemic patients. Pak. J. Biol. Sci., 2011, 14, 282–287.
16. Noroozi M., Zavoshy R., Hashemi J.H., The effect of low calorie diet with canola oil on blood lipids in hyperlipidemic patients. J. Food Nutr. Res., 2009, 48, 178–182.
17. Noroozi M., Zavoshy R., Hashemi J.H., Asefzadeh S., The effect of soy protein with low calorie diet on blood lipids in hyperlipidemic type 2 diabetic patients. J. Food Lipids, 2008, 15, 398–406.
18. Olufadi R., Byrne C.D., Effects of VLDL and remnant particles on platelets. Pathophysiol. Haemost. Thromb., 2006, 35, 281–291.
19. Perez-Guisado J., Munoz-Serrano A., Alonso-Moraga A., Spanish Ketogenic Mediterranean Diet, a healthy cardiovascular diet for weight loss. Nutr. J., 2008, 26, 30–31.
20. Psaltopoulou T., Naska A., Orfanos P., Trichopoulos D., Mountokaakis T., Trichopoulou A., Olive oil, the Mediterranean diet, and arterial blood pressure: the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) study. Am. J. Clin. Nutr., 2004, 80, 1012–1018.
21. Rudd J., Davies J.R., Weissberg P.L., Imaging of atherosclerosis-can we predict plaque rupture? Trends Cardiovasc. Med., 2005, 15, 17–24.
22. Rueda-Clausen C.F., Silva F.A., Lindarte M.A., Villa-Roel C., Gomez E., Gutierrez R., Cure-Cure C., Lopez-Jaramillo P., Olive, soybean and palm oils intake have a similar acute detrimental effect over the endothelial function in healthy young subjects. Nutr. Metab. Cardiovasc. Dis., 2007, 17, 50–57.
23. Salas-Salvado J., Fernandez-Ballart J., Ros E., Martinz-Gonzalez M.A., Fito M., Gomez-Grasia E., Aros F., Flores G., Lapetra J., Covs M.I., PREDIMED Study Investigators. Effect of a Mediterranean diet supplemented with nuts on metabolic syndrome status: one-year results of the Predimed randomized trial. Arch. Intern. Med. 2008, 168, 2449–2458.
24. Sodergren E., Gustafsson I.B., Basu S., Nourooz-Zadeh J., Nalsen C., Turpeinen A., Berglund L., Vessby B., A diet containing rapeseed oil-based fats does not increase lipid peroxidation in humans when compared to a diet rich in saturated fatty acids. Eur. J. Clin. Nutr., 2001, 55, 922–931.
25. Stark A.H., Madar Z., Olive oil as a functional food: epidemiology and nutritional approaches. Nutr. Rev., 2002, 60, 170–176.
26. Tapozada S.T., El-Shebini S.M., Hanna L.M., Mohamed H.I., Ghattas LA., Monitoring obesity during dietary therapies using hypocaloric diet and vegetable soup supplement. Pol. J. Food Nutr. Sci., 2007, 57, 381–386.
27. Trichopoulos D., Lagiou P., Mediterranean diet and cardiovascular epidemiology. Eur. J. Epidemiol., 2004, 19, 7–8.
28. Waterman E., Lockwood B., Active components and clinical applications of olive oil. Altern. Med. Rev., 2007, 12, 331–342.

Received November 2010. Revision received June and accepted July 2011. Published on-line on the 18th of January 2012.